OFFICE OF SCIENCE AND TECHNOLOGY POLICY

ACTION: Notice of Request for Information (RFI).

SUMMARY: The purpose of this Request for Information (RFI) is to solicit input from all interested parties regarding recommendations for the development of a National Plan for Civil Earth Observations ("National Plan"). The public input provided in response to this Notice will inform the Office of Science and Technology Policy (OSTP) as it works with Federal agencies and other stakeholders to develop this Plan.

DATES: Responses must be received by December 6, 2013 to be considered.

SUBMISSION: You may submit comments by any of the following methods.

- Downloadable form: To aid in information collection and analysis, OSTP encourages responses to be provided using this form. Please enter your responses in the fillable fields that follow the questions below.
- Email: OSTP encourages respondents to email the completed form, as an attachment, to earthobsplan@ostp.gov. Please include "National Plan for Civil Earth Observations" in the subject line of the message.
- Fax: (202) 456-6071.
- Mail: Office of Science and Technology Policy, 1650 Pennsylvania Avenue, NW, Washington, DC, 20504. Information submitted by postal mail should allow ample time for processing by security.

Response to this RFI is voluntary. Respondents need not reply to all questions listed. Each individual or institution is requested to only submit one response. Responses to this RFI, including the names of the authors and their institutional affiliations, if provided, may be posted on line. OSTP therefore requests that no business proprietary information, copyrighted information, or personally-identifiable information be submitted in response to this RFI. Given the public and governmental nature of the National Plan, OSTP deems it unnecessary to receive or to use business proprietary information in its development. Please note that the U.S. Government will not pay for response preparation, or for the use of any information contained in the response.

FOR FURTHER INFORMATION CONTACT:

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SUPPLEMENTARY INFORMATION:

Background

The U.S. Government is the world's largest single provider of civil environmental and Earth-system data. These data are derived from Earth observations collected by numerous Federal agencies and partners in support of their missions and are critical to the protection of human life and property; economic growth; national and homeland security; and scientific research. Because they are provided through public funding, these data are made freely accessible to the greatest extent possible to all users to advance human knowledge, to enable industry to provide value-added services, and for general public use.

Federal investments in Earth observation activities ensure that decision makers, businesses, first responders, farmers, and a wide array of other stakeholders have the information they need about climate and weather; natural hazards; land-use change; ecosystem health; water; natural resources; and other characteristics of the Earth system. Taken together, Earth observations provide the indispensable foundation for meeting the Federal Government's long-term sustainability objectives and advancing the Nation's societal, environmental, and economic well-being.

As the Nation's capacity to observe Earth systems has grown, however, so has the complexity of sustaining and coordinating civil Earth observation research, operations, and related activities. In October 2010, Congress charged the Director of OSTP to address this challenge by producing and routinely updating a strategic plan for civil Earth observations (see *National Aeronautics and Space Administration Authorization Act of 2010, Public Law 111-267, Section 702*).

Responding to Congress, in April 2013, OSTP released a National Strategy for Civil Earth Observations ("the National Strategy").

In April 2013, OSTP also re-chartered the U.S. Group on Earth Observations (USGEO) Subcommittee of the National Science and Technology Council's Committee on Environment, Natural Resources, and Sustainability. USGEO will carry out the National Strategy and support the formulation of the National Plan.

As requested by Congress, the National Plan is being developed by USGEO to advise Federal agencies on the Strategy's implementation through their investments in and operation of civil Earth observation systems. The Plan will provide a routine process, on a three-year cycle, for assessing the Nation's Earth observation investments; improving data management activities; and enhancing related interagency and international coordination. Through this approach, the Plan will seek to facilitate stable, continuous, and coordinated Earth observation capabilities for the benefit of society.

Congress also requested that development of the National Plan include a process for collecting external independent advisory input. OSTP is seeking such public advisory input through this RFI. The public input provided in response to this Notice will inform OSTP and USGEO as they work with Federal agencies and other stakeholders to develop the Plan.

Definitions and Descriptions

The term "**Earth observation**" refers to data and information products from Earth-observing systems and surveys.

"**Observing systems**" refers to one or more sensing elements that directly or indirectly collect observations of the Earth, measure environmental parameters, or survey biological or other Earth resources (land surface, biosphere, solid Earth, atmosphere, and oceans).

"**Sensing elements**" may be deployed as individual sensors or in constellations or networks, and may include instrumentation or human elements.

"**Observing system platforms**" may be mobile or fixed and are space-based, airborne, terrestrial, freshwater, or marine-based. Observing systems increasingly consist of integrated platforms that support remotely sensed, *in-situ*, and human observations.

Assessing the Benefits of U.S. Civil Earth Observation Systems

To assist decision-makers at all levels of society, the U.S. Government intends to routinely assess its wide range of civil Earth observation systems according to the ability of those systems to provide relevant data and information about the following Societal Benefit Areas (SBAs):

1. Agriculture and Forestry
2. Biodiversity
3. Climate
4. Disasters
5. Ecosystems (Terrestrial and Freshwater)
6. Energy and Mineral Resources
7. Human Health
8. Ocean and Coastal Resources and Ecosystems
9. Space Weather
10. Transportation
11. Water Resources
12. Weather

The U.S. Government also intends to consider how current and future reference measurements (*e.g.*, bathymetry, geodesy, geolocation, topography) can enable improved observations and information delivery.

To address measurement needs in the SBAs, the U.S. Government operates a wide range of atmospheric, oceanic, and terrestrial observing systems. These systems are designed to provide: (a) sustained observations supporting the delivery of services, (b) sustained observations for research, or (c) experimental observations to address specific scientific questions, further technological innovation, or improve services.

Questions to Inform Development of the National Plan

Name (optional): Brian Peck-Sheng Wee, Ph.D.

Position (optional): Chief of External Affairs

Institution (optional): National Ecological Observatory Network (NEON), Inc.

Through this RFI, OSTP seeks responses to the following questions:

1. Are the 12 SBAs listed above sufficiently comprehensive?

While it is desirable to derive a SBA constellation that is representative of the diverse needs and constituent priorities, deriving an optimal SBA constellation is likely to be beyond the means of any reasonably-sized effort. Designing SBAs that are mutually exclusive and that serve multiple constituencies in a commensurate manner is challenging. Moreover, there are some benefits to maintaining some alignment with the GEOSS SBAs.

The NSTC may wish to weigh the relative investment of resources between re-configuring the SBA constellation versus the **identification of shared data sources and tools between SBAs**. For example, the “Agricultural and Forestry” and “Ecosystems (Terrestrial and Freshwater)” SBAs share common data sources and tools. A better understanding of agro-ecosystem processes (e.g. biogeochemistry, hydrology, energy and mass balance processes, etc) is fundamental to more accurately generating forecasts for food, feed, fiber, and feed stock, as they are for estimating critical key measurements for unmanaged ecosystems (e.g. carbon sequestration, water-use efficiency, etc).

Identification of such common elements may be facilitated through the use of **compelling use-cases that overlap multiple SBAs**. Use-cases provide a suite of exemplars that people often identify and rally around. Compelling use-cases are often useful in overcoming the “not invented here” syndrome, because use-cases are a specific species of “stories”, which have been shown to be pedagogically effective in engaging target audiences.

An exemplar cross-cutting use-case for the related SBAs of “Agricultural and Forestry” and “Ecosystems (Terrestrial and Freshwater)” can be derived around questions related to (a) changes in carbon sequestration as a function of management practices across a variety of land-use gradients, including natural and intensively managed lands, (b) determining reliable and scientifically defensible metrics for quantifying ecosystem benefits (*Fleishman, Erica, David E. Blockstein, John A. Hall, Michael B. Mascia, Murray A. Rudd, J. Michael Scott, William J. Sutherland et al. "Top 40 priorities for science to inform US conservation and management policy." Bioscience 61, no. 4 (2011): 290-300.).*

   a. Should additional SBAs be considered?

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b. Should any SBA be eliminated?

The “Disasters” SBA may benefit from some consideration to be renamed, despite the fact that the original GEOSS SBAs included “Disasters”. This SBA stands out in stark contrast to the other SBAs like “Ecosystems”, “Human Health”, and “Agriculture and Forestry”.

2. Are there alternative methods for categorizing Earth observations that would help the U.S. Government routinely evaluate the sufficiency of Earth observation systems?

The efforts by the Interagency Assessment Working Group in documenting the value-chain (Figure 1 in the *National Strategy*) revealed certain shortcomings of the way Earth observations are characterized. It was challenging to **consistently distinguish between the closely related concepts** of programs, projects, observation platforms, primary data products, derived data products, and so on.

Additional dimensions of earth observations made the analysis even harder. For example, how would one weigh the relative contribution of an observation system that is no longer in existence, or had morphed into another system, but whose historical data were still critical for ingest into forecast models that used historical data?

Should a group be charged with a similar portfolio analysis in the future, consideration should be given to an **information modeling phase** that defines a suite of clearly documented concepts and controlled vocabulary that help define the relationships between concepts like observation, measurements, data sets, data streams, programs, projects, observation platforms, primary data products, derived data products, and so on. Such concepts would facilitate more agile means to use the raw data for the value-chain analysis (Figure 1 in the *National Strategy*).

The advantage of such an information modeling phase is that it allows (1) members of the Working Group to more accurately **tag the data** (possibly using multiple tags for a given entity) that they generate for the analysis, (2) members of the technical assessment integration team to understand the nuance of the data that they are analyzing to afford the flexibility of selecting data for analysis in a consistent manner (for example, through a Structured Query Language-like manner).

This information modeling phase is often conducted with the help of use-cases, highlighted in the response to RFI question #1. The same response also identifies the need for identification of shared data and tools between SBA. Should this step be undertaken, such an information modeling phase becomes important because of the sheer complexity of the many-to-many connections between the nodes of a very large “SBA traceability graph”, more commonly referred to as a “**traceability matrix**”. Such matrices are derived by systems engineers in complex projects and managed in requirements management software that manages the many-to-many connections between nodes. NEON utilized a similar traceability approach to prioritize its 500+ environmental measurements collected across the nation. The equivalents of SBAs in NEON were Grand Challenge Areas. The matrix enabled trade-off decisions to be made between the measurement (observation) strategy and budget (or some other metric), while retaining integrity in the Grand Challenge Areas.

See also the response to RFI question #4 in this document. It outlines a strategy for how such tagged observation portfolio data may be used to compute metrics that quantify the utility of observation data.

Individuals from the Rensselaer Polytechnic Institute's Tetherless World Constellation (TWC) have experience in this type of information modeling. TWC is the same group that has worked on linked open government data (LOGD) projects, and developed demonstration projects for semantically tagging data from DATA.GOV.

3. What management, procurement, development, and operational approaches should the U.S. Government employ to adequately support sustained observations for services, sustained observations for research, and experimental observations? What is the best ratio of support among these three areas?

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4. How should the U.S. Government ensure the continuity of key Earth observations, and for which data streams (*e.g.*, weather forecasting, land surface change analysis, sea level monitoring, climate-change research)?

Just as the science, informatics, and science-policy communities have widely recognized the need to use data to inform our decisions, the prioritization of key Earth observations should similarly be informed by the **best available data**. This was likely the same motivation that inspired the National Earth Observations Task Force to utilize the SBA integrated assessment approach that utilized MITRE's PALMA tool to derive a national observation system portfolio.

A prioritization scheme should be reproducible and transparent. A method for evaluating the utility of observations is to utilize some metric that takes into account:

1. The length of the value-chain for a given observation (e.g. Landsat ETM+) that results in, say, a derived data product (e.g. National Land Cover Dataset NLCD 2006). Note here that the term "observation" and "derived data product" is used loosely without the benefit of an information modeling exercise (see response to RFI question #2 on information modeling exercise).
2. The number of derived data products that can be traced back to a given observation.

An aggregate score computed using some weighed product of (1) and (2) will inform the **utility of a given observation**. More accurate methods for calculating such scores are the province of network theory, and there is no doubt that there is extensive literature on such metrics. This brief exposition is meant to expose the idea of using such a metric to quantify the utility of such observations.

The formulation of such metrics is not an academic problem in network theory that has little or no chance of implementation in the real world. The informatics community has been proficient in recommending best practices for persistent identifiers (PIDs), capturing the provenance of data products, recommending data citation practices, and so on. These, in addition to commercial initiatives like the Thompson Reuters Data Citation Index, represent the building blocks to enable such metrics to be computed. The USGCRP's Global Change Information System is already incorporating some of these foundational technologies to enable these types of value-chains to be analyzed. Further development in informatics interoperability initiatives that enable these types of capabilities should be encouraged by the US Government.

Such metrics, when computed for a traceability matrix created for use-cases that span multiple SBAs, driven by data appropriately tagged using a consistent vocabulary (see responses to RFI questions #1 and #2), provide a reproducible and transparent means to identifying key Earth observations that should be sustained.

5. Are there scientific and technological advances that the U.S. Government should consider integrating into its portfolio of systems that will make Earth observations more efficient, accurate, or economical? If so, please elaborate.

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6. How can the U.S. Government improve the spatial and temporal resolution, sample density, and geographic coverage of its Earth observation networks with cost-effective, innovative new approaches?

Citizen-science is a potential avenue for increasing the spatio-temporal density of certain observations. Despite the sometimes noted concerns about data quality for citizen collected data, there are many experts who have proposed, tested, and successfully implemented mechanisms that ameliorate such concerns.

Crowd-sourced approaches for characterizing observational data that is difficult or impossible to process using algorithms have also been successfully employed. Such approaches have been successfully implemented within a gaming framework where participants are motivated to navigate a reward structure (e.g. merit badges, ranking, community mentions, etc) in the course of executing cognitive tasks that are difficult or impossible to implement via automated means.

The Government may wish to assess the utility of such approaches in service of the creation of national datasets, like the National Land Cover Dataset (NLCD: see also response to RFI Question #4). The interagency Multi-Resolution Land Characteristic Consortium (MRLC) is responsible for updating the NLCD on a regular basis using a multitude of data sources, and also for completing accuracy assessments of its products. It may be feasible to assess the suitability of utilizing citizen science and crowd-sources approaches for selected sub-tasks for land-cover classification and land-cover verification. For example, it may be feasible to (1) identify land-cover types that have traditionally been problematic for automated algorithm classification, (2) select candidate locations throughout the country that would benefit from some citizen-science (e.g. boots on the ground) or crowd-sourced (e.g. classifying land-cover from high-resolution imagery within a gaming environment) approach, and (3) partner with projects or organizations (e.g. EarthWatch, BioBlitz) to carry out targeted projects.

Such an approach builds **public support** for the creation of national-level data products, and opens an avenue for **engagement on the value of long-term, high-quality observations** that ultimately serve the public good. It is also consistent with the *National Strategy's* call for "Improving User Engagement" (page 19).

The NLCD is one of many candidate national-level data products that may be suitable for the incorporation of such approaches. The data layers currently featured in the EPA's EnviroAtlas are aligned with the recommendations in the *PCAST 2011 report on Sustaining Environmental Capital*. Assessing the candidacy of citizen-science and crowd-sourced approaches within the context of an existing investment like EnviroAtlas facilitates alignment with already identified national needs such as the EcoINFORMA. Integrating these spatially and temporally intensive methods within the context of EcoINFORMA is consistent with the consideration of "Delivering Integrated Information" in the *National Strategy* (page 18).

7. Are there management or organizational improvements that the U.S. Government should consider that will make Earth observation more efficient or economical?

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8. Can advances in information and data management technologies enable coordinated observing and the integration of observations from multiple U.S. Government Earth observation platforms?

Such advances are useful to the extent that there are sufficient resources to **support capacity building for middle-level managers**. Professional development opportunities in this respect should be made available to selected middle-level managers in the Government. Workshops and conferences are excellent tools for getting a sense of the landscape, but are inadequate substitutes for carefully designed training courses that impart key concepts in a manner that compels learners to incorporate new concepts in their daily work.

These managers need to be familiar with key informatics concepts, so that they (1) have the knowledge to adjudicate on resources that should be expended on such technologies within a given agency, (2) have the knowledge to interact with other agency personnel to foster greater interoperability and coordination between agencies.

Just as capacity building of this sort is critical for our early career scientists so that they can be fruitful in a **data-intensive world**, capacity building of a similar nature aimed at acquiring familiarity (and not necessarily mastery) of informatics concepts will enable middle-level managers to enjoy a fulfilling public service career, and for the US to fully reap the benefits of emerging technology. A knowledge deficit in such regards leads to insecurity about committing resources to advance the state of the art.

9. What policies and procedures should the U.S. Government consider to ensure that its Earth observation data and information products are fully discoverable, accessible, and useable?

The technical barriers for discoverability, accessibility, and usability are very tractable. In most cases, members of the informatics community are very familiar with the trade-space within which they need to draw technical solutions from. These technical approaches form the bulk of discussions at data interoperability fora like the Federation of Earth Science Information Partners (ESIP), NSF's EarthCube, and the Research Data Alliance (RDA). Undoubtedly, there are still many technical challenges to overcome, but incremental progress in such issues is evident over the course of a few short years.

We would not be the first to offer that the more severe challenges are those related to **organizational-cultural barriers**. No amount of technical innovation will help overcome barriers related to lack of incentive, for example. Scientists may not be motivated to expend effort in making data discoverable and repurposable by carefully documenting their data, even if they realize that there are co-benefits to good metadata (e.g. they themselves will better understand the assumptions of their own data when they look at it five years later).

This is only one of many organizational-cultural barriers. The more intractable ones are related to shrinking budgets and the vagaries of Congressional appropriations. This impedes planning and dedication of resources for making data discoverable, accessible, and usable.

Certain **cultural barriers can be gradually weakened**, however. Targeted capacity building (see response to RFI question #8) is an example of such a change agent that can help break down cultural barriers. Another way is to design metrics that indicate the level of effort levied towards facilitating the repurposing of data and information. Such metrics may be incorporated into performance evaluations at the personnel level, or at some organizational level (e.g. at the level of a department within a bureau or agency). A similar strategy was used by Andersen Consulting in the 1990s (now Accenture: a strategic, IT, and business consulting global powerhouse) to incentivize employees to contribute to the corporate Lotus Notes knowledge-base. One of the performance evaluation criteria for employees assessed the extent to which employees had contributed to that corporate knowledge-base. Evaluation criteria fashioned in a similar manner would have to be rolled-out with due deliberation within the US Government: it would only be relevant to certain groups of Federal employees, and subject to legal scrutiny to ensure compliance with applicable laws and policies.

Sufficient attention should also be paid to the issue of data policies that may impinge on the ability to repurpose data and information. This gets into the province of the **legal interoperability of data**. A summary GEOSS Data Collection of Open Resources for Everyone (Data-CORE) white paper on "Legal Options for the Exchange of Data Through the GEOSS Data-CORE" (October 2012) defines legal interoperability as "*data from two or more databases may be combined or otherwise reused by any user without compromising the legal rights of any of the data sources used*". An example of a data interoperability challenge is when data (e.g. species occurrence record) is released under an attribution license (e.g. Creative Commons Attribution), and when a biodiversity model (e.g. species habitat range) ingests thousands of individual records, the researcher is then bound by license to attribute the final product (e.g. habitat range map) to possibly hundreds of "authors" because of the attribution requirement. This example illustrates the "attribution stacking" license interoperability challenge.

The myriad complexities of legal interoperability are beyond the scope of this RFI response. These types of issues are deliberated on by members of the National Academies' Board on Research Data and Information and US CODATA who have authored relevant publications on this matter.

10. Are there policies or technological advances that the U.S. Government should consider to enhance access to Earth observation data while also reducing management redundancies across Federal agencies?

See response to RFI question #9 on legal interoperability of data.

11. What types of public-private partnerships should the U.S. Government consider to address current gaps in Earth observation data coverage and enhance the full and open exchange of Earth observation data for national and global applications?

The *PCAST 2011 report on Sustaining Environmental Capital* makes the case that the Government has a unique and indispensible role in common-property resources that provide the essential ecosystem services from which individuals and firms derive benefits from. The report states "*The government's capacity to appropriately influence the behavior of private actors toward environmental capital, as well as to better manage the environmental capital that is directly under the government's control, can be improved both by better use of available understandings, models, and data on these matters and by focused efforts to upgrade the relevant understandings, models, and databases over time*."

Credible, high-quality, long-term environmental data enables improved forecast models that ultimately enable the private sector to provide essential goods and services to society: one of the rationales behind DATA.GOV and the White House's Datapaloozas.

The Government should capitalize on the growing momentum in these areas to bring the conversation **further back along the value-chain** of data-to-information-to-knowledge creation. These conversations would address questions like: How would additional measurements, higher-quality data, data quality descriptors, etc help the private sector produce better goods and services for their clients? How would better environmental observatory interoperability enable ingest of that data by the private sector? To what degree is data fusion across different credible data sources impacted by a lack of data quality descriptors in order to assess **fitness-for-use**? To what extent is the private sector using the same technical standards that are being promulgated by the US Federal agencies?

The private sector should be actively encouraged to participate in and co-sponsor interoperability fora that focus on **data interoperability <u>and</u> measurement interoperability challenges**. Data interoperability focuses on issues like standards (for data formats, metadata, web services, provenance, identifiers), ontologies, data licensing, policies, legal constraints, authentication, identity management, access management, and other areas. Fora like ESIP, EarthCube, and the RDA exist for such knowledge exchange (see response to RFI question #9).

Data interoperability is not a sufficient condition for repurposable data that usable, however. In the extreme case, two time-series datasets may be fully discoverable and accessible through web services, but one time series is guaranteed comparable over the course of decades (e.g. Keeling curve data from Mauna Loa), but another time series is from a source that has not demonstrated the same fidelity afforded through thoughtful QA/QC (e.g. regular calibration and validation). Measurement interoperability, especially between environmental observatories, addresses issues like QA/QC. Other observation science include: measurement traceability to recognized standards (also recognized in the *National Strategy*, page 14, "Reference Measurements"), ascertaining signal to noise ratio, QA/QC best practices, quantifying uncertainty budgets, partitioning uncertainty budgets, etc.

NEON's environmental observatory interoperability framework (presented to the PCAST in September 2013) comprises four elements, two of which are data interoperability and measurement interoperability. The latter is especially critical when applications need to assess fitness-for-use and require an assessment of data quality prior to ingest into models.

Data and measurement interoperability fora could also be used by the private sector to acquire information about environmental observatories' measurement needs. Provided that certain procurement-related legal requirements are identified a-prori and appropriate remediation measures implemented, use-cases can drive discussions about operational constraints experienced by observatories that may be ameliorated by improvements in measurement technology created by the private sector. This ultimately helps the private sector develop technologies that address the needs identified in the observations portfolio assessment, which may in turn benefit the Government by reducing operational costs through improved technology. Further consideration should be given as to how this approach should be executed because the Department of Energy's National Laboratories and the Department of Commerce's National Institute of Standards and Technology both play important roles in fostering such technology innovation.

Given that fitness-for-use is an issue that speaks to the fidelity of derived data products and information that are generated for applied purposes by both the Government and by private industry, fora that address both measurement and data interoperability would be beneficial to many of the SBAs that are included in the *National Strategy*.

12. What types of interagency and international agreements can and should be pursued for these same purposes?

In light of the challenges facing agriculture over the next few decades, USDA and NEON leaders have been exchanging information on strategies for leveraging existing investments. Discussions have focused on the establishment of partnerships and the sharing of techniques, protocols, best practices, and physical infrastructure. In late 2012, the USDA launched its **Long-Term Agro-Ecosystem Research** (LTAR) network with an initial configuration of ten sites, three of which are co-located with NEON. The LTAR and NEON share high-level scientific goals, making this nascent collaboration potentially very fruitful.

In addition, NOAA and NEON have been exchanging ideas on approaches to integrate terrestrial and coastal observations.   **Coastal and near-shore ecosystems** are experiencing multiple stressors that will be exacerbated by climate change and ocean acidification (*Burkett, V.R. and Davidson, M.A. [Eds.]. (2012). Coastal Impacts, Adaptation and Vulnerability: A Technical Input to the 2012 National Climate Assessment. Cooperative Report to the 2013 National Climate Assessment., pp. 150*).   The connectivity between terrestrial and near-coastal systems is poorly understood and affects ecosystem services, transportation of nutrients, biodiversity, and ecosystem resilience. The paucity of integrated terrestrial and near-coastal observations in a consistent manner **designed to scale-up to the entire continent** is a barrier to better forecasting the impacts of large-scale environmental changes that will impact the economic vitality of coastal communities. In 2010, more than 39% of Americans live in coastal shoreline counties. These counties represent less than 10% of the US Land area, but are responsible for over half of the 2011 US GDP (State of the Coast, NOAA).

Both of the collaborations described above are still in their early phases, and we continue to assess opportunities to advance work on areas of **environmental observatory interoperability** on agro-ecosystems and coastal and near-shore ecosystems (see also response to RFI question #11 on environmental observatory interoperability).

On the international front, there exist multiple programs that US agencies participate in. Although these are primarily aimed at fostering basic scientific research, and not necessarily mission-focused scientific research, the increased emphasis on making observational data discoverable, accessible, and useable facilitates the **transition from research to operations**. This does not guarantee, but instead facilitates, such data and information to be repurposable for mission-driven science and applied programs. Further consideration will be necessary to assess how the benefits (data, information, technical solutions, approaches, etc) of such research can be more fully propagated within the US for US operational needs. Examples of such international programs include:

- NSF is party to the Belmont Forum (http://igfagcr.org/index.php/belmont-forum), comprising the national research foundations of countries like South African, France, Australia, Japan, Norway, the USA, and other countries. Other members include the International Council for Science (ICSU) and the International Social Science Council (ISSC). The Forum funds international collaborations in the area of global change research. There is recognition of advanced observing systems playing an important role in providing data for science and society. There is also recognition of the importance of integrating social sciences and natural sciences, something that is reflected in the USGCRP's *National Global Change Research Plan 2012,* the *PCAST 2011 report on Sustaining Environmental Capital*, and other policy-relevant documents.
- Horizon2020 is the upcoming successor to the European Union's Framework Programme 7 (FP7). Although not strictly designed to foster global change research, Horizon2020 includes an element of addressing societal challenges by bridging the gap between research and the market, which speaks to the private-partner partnerships addressed in RFI question #11.
- Although not strictly in the same category as the Belmont Forum and Horizon2020, the Intergovernmental Platform on Biodiversity and Ecosystem Services (IPBES) was highlighted in the *PCAST 2011 report on Sustaining Environmental Capital*. That report suggested that OSTP and the US Department of State should take a leading role in the US contribution to IPBES.

The COOPEUS project (http://www.coopeus.eu/) is a US NSF – European Union FP7 funded project to strengthen the cooperation between the EU and the US in the field of environmental research infrastructures. Europe's major environmental related research infrastructure projects involved include EISCAT (space weather), EPOS (solid earth dynamics), EMSO (ocean observatories), LifeWATCH (biodiversity), and ICOS (carbon observatories), with their corresponding US counterparts that are responsible for the NSF funded projects AMISR, EARTHSCOPE, Oceans Observatories Initiative, and NEON. NEON leads the US group of NSF-funded environmental observatories. The ultimate objective of this integration process is the efficient access to and the open sharing of data and information produced by the environmental research infrastructures.